![Medtronic logo] **Medtronic**	*Neurological*	**Document Number** 288117-70205	Rev/Version 1.0	Sht 1 of 49
Title: Neuro Patient Programmer Platform Electrical DVT Report				

Revision History:

Revision	Comments
1.0	Initial release for routing

![Medtronic logo] **Medtronic**	*Neurological*	Document Number 288117-70205	Rev/Version 1.0	Sht 2 of 49
Title: Neuro Patient Programmer Platform Electrical DVT Report				

⟨logo⟩ **Medtronic**	*Neurological*	**Document Number** **288117-70205**	**Rev/Version** 1.0	**Sht** 3 of 49
Title: Neuro Patient Programmer Platform Electrical DVT Report				

1 INTRODUCTION

This document is the electrical Design Verification Test (DVT) Report for the 37741 Patient Programmer Platform.

1.1 Purpose

The purpose of this report is to document the results of test plan.

1.2 Scope

This report applies only to design verification testing of the 37741 Patient Programmer Platform.

1.3 Document Overview

This document is organized as follows:

- Section 2 contains references and definitions.
- Section 3 contains a table with the list of tests, software revisions, sample sizes, and test results.
- Section 4 contains the results of the electrical design verification tests.

![Medtronic logo] **Medtronic**	*Neurological*	Document Number 288117-70205	Rev/Version 1.0	Sht 4 of 49
Title: Neuro Patient Programmer Platform Electrical DVT Report				

2   REFERENCES AND DEFINITIONS

This section identifies internal and external reference documents that augment the information provided in this document. It also defines terms, acronyms, and abbreviations used within the document.

2.1   Internal Medtronic References

Number	Name
120275	
215387	
288117-70040	
288117-70044	
288117-70029	
503011001	
288117-70200	

Note: Document revisions referenced in DVT Plan.

2.2   External References

Reference the PEM Electrical Specification for external specification standards.

2.3   Definitions, Acronyms, and Abbreviations

ARB: Arbitrary Waveform Generator

ARB equipment: One or more arbitrary waveform generators, used alone or in conjunction to generate sophisticated waveforms.

DUT: Device Under Test

DVT: Design Verification Test

DVT Console: The test console needed to perform the tests specified herein.

ES: Electrical Specification #120275

GPIB: General Purpose Interface Bus

PEM: Patient Electronic Module

PP: Patient Programmer

POR: Power On Reset

Medtronic	*Neurological*	Document Number 288117-70205	Rev/Version 1.0	Sht 5 of 49

Title: Neuro Patient Programmer Platform Electrical DVT Report

3 Test Results Summary

Table 1 summarizes the results of all electrical design verification testing. Section 4 details each test setup, criteria, and results.

- Test data is stored as 288117-70200.
- Table 1 indicates test name, sample size, DUT software revision, Test Script Software revision, test path, and results.
- Test paths are shown in section 3.1.

Table 1

Test Name	Sample Size	DUT Software Revision	Script Software Test Revision	Test Path	Results
	22				PASS
	22				PASS
	22				PASS
	22				PASS
	22				PASS
	22				PASS
	22				PASS
	22				PASS
	22				PASS
	22				PASS
	22				PASS
	22				PASS
	22				PASS
	22				PASS
	22				PASS
	22				PASS
	22				PASS
	22				PASS
	22				PASS
	22				PASS
	22				PASS
	1				PASS

Medtronic	*Neurological*	**Document Number** 288117-70205	Rev/Version 1.0	Sht 6 of 49
Title: Neuro Patient Programmer Platform Electrical DVT Report				

3.1 Test Paths
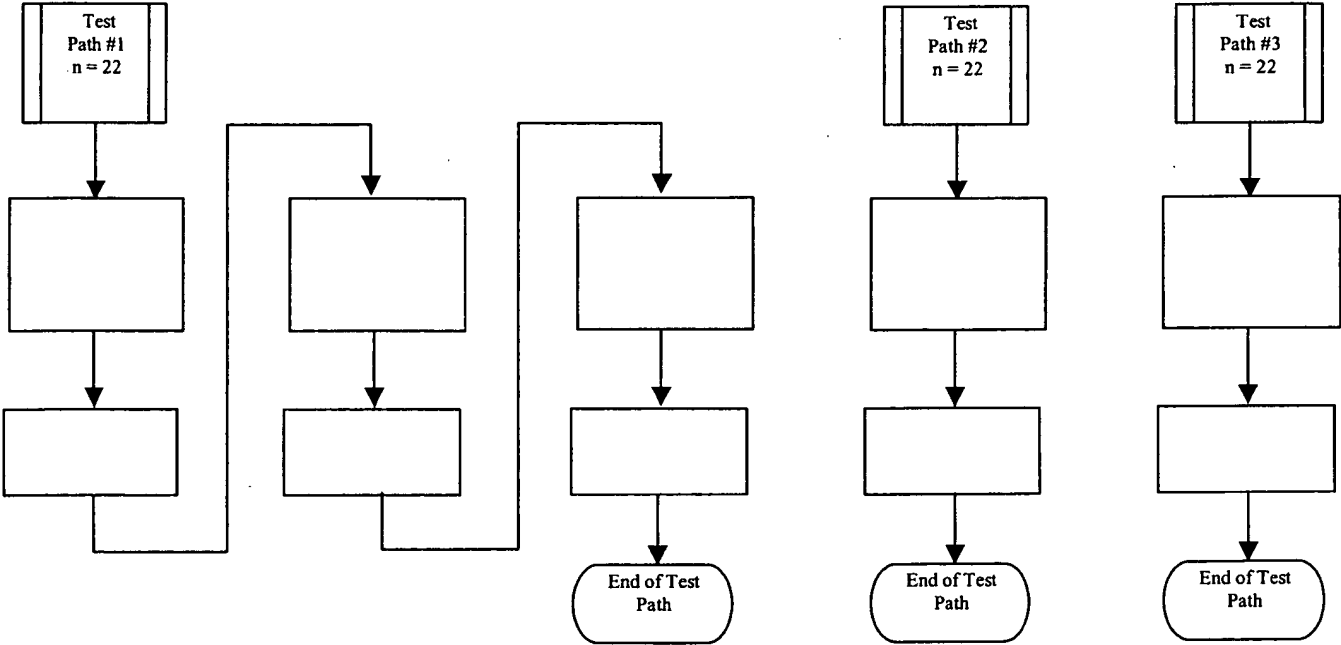
![Medtronic logo] **Medtronic**	*Neurological*	**Document Number** 288117-70205	Rev/Version 1.0	Sht 7 of 49
Title: Neuro Patient Programmer Platform Electrical DVT Report				

4   ELECTRICAL TESTS

This section specifies electrical tests performed on the 37741 Patient Programmer Platform.

4.1   Power Source Tests

4.1.1 Current Drain Test

4.1.1.1   Objective

To verify the current drain meets the requirements specified in the *Power Source* section of the PEM Electrical Specification.

4.1.1.2   Method and Equipment

4.1.1.3   Test Cases

There are _ test cases for transmit using all combinations of test values below:

Parameter	Test Values	Units

The

There are   test cases   using all combinations of test values below:

Parameter	Test Values	Units

There are   test cases   using two combinations of test values below:

Parameter	Test Values	Units

There are   total test cases.

4.1.1.4   Acceptance Criteria

![Medtronic logo] **Medtronic**	*Neurological*	**Document Number** 288117-70205	**Rev/Version** 1.0	**Sht** 8 of 49

Title: Neuro Patient Programmer Platform Electrical DVT Report

Operating Condition (Ref.)	Antenna	Duty Cycle (%)	Current Drain (mA) MAX		
			V	V	V
Row A	INT				
Row B	INT				
Row C	INT				
Row D	INT				
Row E	INT				
Row F	INT				
Row G	INT				
Row H	EXT				
Row I	INT				
Row J	INT				

Note 1:

4.1.1.5   *Test Setup*
1.
2.
3.

4.

4.1.1.6   *Test Procedure*
1.
2.

3.

4.

	Medtronic	*Neurological*	Document Number 288117-70205	Rev/Version 1.0	Sht 9 of 49

Title: Neuro Patient Programmer Platform Electrical DVT Report

4.1.1.7 *RESULTS* **PASS**

All devices met the acceptance criteria.

Operating Condition	Current Drain (mA) MAX															
Row	Spec	Min	Max	Mean	Std Dev		Spec	Min	Max	Mean	Std Dev		Spec	Min	Max	Mean	Std Dev	
A																		
B																		
C																		
D																		
E																		
F																		
G																		
H																		
I																		
J																		

4.1.2 Supply Voltage Range Test

4.1.2.1 *Objective*

To verify the supply voltage range meets the requirements specified in the *Power Source* section of the PEM Electrical Specification.

4.1.2.2 *Method and Equipment*

4.1.2.3 *Test Cases*

Medtronic	*Neurological*	**Document Number** **288117-70205**	**Rev/Version** 1.0	**Sht** 10 of 49
Title: Neuro Patient Programmer Platform Electrical DVT Report				

Parameter	Test Values	Units

The

There is   test case without transmit:

Parameter	Test Values	Units

4.1.2.4   *Acceptance Criteria*

Operating Condition	Antenna	H-Bridge Drive Duty Cycle (%)	Min operating voltage (V)

4.1.2.5   *Test Setup*
1.
2.
3.

4.

4.1.2.6   *Test Procedure*
1.

2.

3.

![Medtronic logo] **Medtronic**	*Neurological*	**Document Number** **288117-70205**	**Rev/Version** 1.0	**Sht** 11 of 49
Title: Neuro Patient Programmer Platform Electrical DVT Report				

4.1.2.7 *RESULTS* **PASS**

All devices met the acceptance criteria.

Operating Condition	Antenna	Supply Voltage Range (Volts)				
		Min	Max	Avg	Std Dev	
—	—	—	—	—	—	—
—	—	—	—	—	—	—

4.2 Input/Output Connections Tests

4.2.1 Keypad Interface Test

4.2.1.1 *Objective*

To verify the keypad interface meets the requirements specified in the *Input/Output Connections* section of the PEM Electrical Specification.

4.2.1.2 *Method and Equipment*

4.2.1.3 *Test Cases*

Parameter	Test Values	Units

4.2.1.4 *Acceptance Criteria*

4.2.1.5 *Test Setup*
1.
2.

3.

4.2.1.6 *Test Procedure*

![Medtronic logo] **Medtronic**	*Neurological*	**Document Number** **288117-70205**	**Rev/Version** 1.0	**Sht** 12 of 49
Title: Neuro Patient Programmer Platform Electrical DVT Report				

3.

4.2.1.7   *RESULTS*   **PASS**

All devices met the acceptance criteria.

Tests	Keypad Interface (pass/fail)		
	Pass	Pass	Pass
	Pass	Pass	Pass

4.2.2 Display Interface Test

4.2.2.1   *Objective*

To verify the display interface meets the requirements specified in the *Input/Output Connections* section of the PEM Electrical Specification.

4.2.2.2   *Method and Equipment*

4.2.2.3   *Test Cases*

There are   test cases using combinations of the test values below:

Parameter	Test Values	Units

![Medtronic logo] **Medtronic**	*Neurological*	**Document Number** **288117-70205**	**Rev/Version** 1.0	**Sht** 13 of 49
Title: Neuro Patient Programmer Platform Electrical DVT Report				

4.2.2.4 _Acceptance Criteria_

Test Parameters				Requirements			

4.2.2.5 _Test Setup_

1.
2.

3.

4.2.2.6 _Test Procedure_

1.

2.
3.

4.

4.2.2.7 _RESULTS_ **PASS**

All devices met the acceptance criteria.

Test	Display Interface (pass/fail)		
	Pass	Pass	Pass
	Pass	Pass	Pass
	Pass	Pass	Pass

![Medtronic logo] **Medtronic**	*Neurological*	**Document Number** **288117-70205**	Rev/Version 1.0	Sht 14 of 49
Title: Neuro Patient Programmer Platform Electrical DVT Report				

4.2.3 External Antenna Interface Test

4.2.3.1   Objective

To verify the external antenna interface meets the requirements specified in the *Input/Output Connections* section of the PEM Electrical Specification.

4.2.3.2   Method and Equipment

4.2.3.3   Test Cases

There are   test cases using all combinations of test values below:

Parameter	Test Values	Units

4.2.3.4   Acceptance Criteria

- When an external antenna is connected, there should be no downlink from the internal antenna.

- When an external antenna is connected, the uP should detect that the antenna is connected.

External Antenna					
	Min	**Max**	**Min**	**Max**	**Yes/No**

4.2.3.5   Test Setup

1.

2.

3.

4.

5.

![Medtronic logo] **Medtronic**	*Neurological*	**Document Number** **288117-70205**	Rev/Version 1.0	Sht 15 of 49
Title: Neuro Patient Programmer Platform Electrical DVT Report				

4.2.3.6   *Test Procedure*

1.

2.
3.
4.

4.2.3.7   *RESULTS*   **PASS**

All devices met the acceptance criteria.

![Medtronic logo] **Medtronic**	*Neurological*	**Document Number** 288117-70205	Rev/Version 1.0	Sht 16 of 49
Title: Neuro Patient Programmer Platform Electrical DVT Report				

Test Configuration	Test
	A
	B

Test	External Antenna Interface (A/m)											
	Min	Max	Mean	Std dev	Min	Max	Mean	Std dev	Min	Max	Mean	Std dev
A												
B												

4.2.4 Infrared Port Interface Test

4.2.4.1 *Objective*

To verify the infrared port interface meets the requirements specified in the *Input/Output Connections* section of the PEM Electrical Specification. [PTPROG_PEMT-0006:*]

4.2.4.2 *Method and Equipment*

4.2.4.3 *Test Cases*

There are   test cases using all combinations of test values below:

Parameter	Test Values	Units

4.2.4.4 *Acceptance Criteria*

All	All	None

4.2.4.5 *Test Setup*

1.

2.

![Medtronic logo] **Medtronic**	*Neurological*	**Document Number** **288117-70205**	**Rev/Version** 1.0	**Sht** 17 of 49
Title: Neuro Patient Programmer Platform Electrical DVT Report				

3.

4.2.4.6 Test Procedure

1.

2.

3.

4.

4.2.4.7 RESULTS **PASS**

All devices met the acceptance criteria.

	Infrared (pass/fail)								
Voltage (V)									
	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass

4.2.5 Audio Transducer Test

4.2.5.1 Objective

To verify the audio transducer meets the requirements specified in the *Input/Output Connections* section of the PEM Electrical Specification.

4.2.5.2 Method and Equipment

4.2.5.3 Test Cases

There are   test cases using all combinations of test values below:

Medtronic	*Neurological*	**Document Number** **288117-70205**	**Rev/Version** 1.0	**Sht** 18 of 49

Title: Neuro Patient Programmer Platform Electrical DVT Report

Parameter	Test Values	Units

4.2.5.4 *Acceptance Criteria*

4.2.5.5 *Test Setup*
1.
2.
3.
4.

5.

4.2.5.6 *Test Procedure*
1.
2.
3.
4.

4.2.5.7 *RESULTS* **PASS**

All devices met the acceptance criteria.

	Audio Transducer (dB SPL)											
	Min	Max	Mean	Std dev	Min	Max	Mean	Std dev	Min	Max	Mean	Std dev

4.2.6 Manufacturing/Test Interface Test

Manufacturing requirements defined in Test Specification, Patient Programmer, 215387.

![Medtronic logo] **Medtronic**	*Neurological*	**Document Number** **288117-70205**	**Rev/Version** 1.0	**Sht** 19 of 49

Title: Neuro Patient Programmer Platform Electrical DVT Report

4.3 Internal Resources Tests

4.3.1 Memory Test

4.3.1.1 *Objective*

To verify the internal memory resources meet the requirements specified in the *Internal Resources* section of the PEM Electrical Specification.

4.3.1.2 *Method and Equipment*

4.3.1.3 *Test Cases*

There are ___ test cases using all combinations of test values below:

Parameter	Test Values	Units

4.3.1.4 *Acceptance Criteria*

All	Pass

4.3.1.5 *Test Setup*

1.
2.

3.

4.3.1.6 *Test Procedure*

1.
2.
3.
4.

4.3.1.7 *RESULTS* **PASS**

All devices met the acceptance criteria.

Test	Memory (pass/fail)		
	Pass	Pass	Pass
	Pass	Pass	Pass
	Pass	Pass	Pass

![Medtronic logo] **Medtronic**	*Neurological*	**Document Number** **288117-70205**	Rev/Version 1.0	Sht 20 of 49
Title: Neuro Patient Programmer Platform Electrical DVT Report				

4.3.2 Real-Time Clock Backup Test

4.3.2.1 *Objective*

To verify the real-time clock backup meets the requirements specified in the *Internal Resources* section of the PEM Electrical Specification.

4.3.2.2 *Method and Equipment*

4.3.2.3 *Test Cases*

There is one test case below:

Parameter	Test Value	Units

4.3.2.4 *Acceptance Criteria*

Test Case	Min Time w/o power (min)

4.3.2.5 *Test Setup*

1.
2.

3.

4.3.2.6 *Test Procedure*

1.
2.
3.
4.
5.

4.3.2.7 *RESULTS* **PASS**

All devices met the acceptance criteria.

Medtronic	*Neurological*	Document Number 288117-70205	Rev/Version 1.0	Sht 21 of 49

Title: Neuro Patient Programmer Platform Electrical DVT Report

Test	Real-Time Backup (pass/fail)		
	Pass	Pass	Pass

4.3.3 Real-Time Clock Accuracy Test

4.3.3.1 *Objective*

To verify the real-time clock accuracy meets the requirements specified in the *Internal Resources* section of the PEM Electrical Specification.
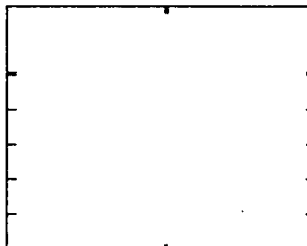
4.3.3.2 *Method and Equipment*

4.3.3.3 *Test Cases*

There are   test cases (actually measurement points) using all combinations of test values below:

Parameter	Test Value	Units

4.3.3.4 *Acceptance Criteria*

4.3.3.5 *Test Setup*
1.
2.

4.3.3.6 *Test Procedure*
1.

2.

4.3.3.7 *RESULTS* **PASS**

All devices met the acceptance criteria.

![Medtronic logo] **Medtronic**	*Neurological*	**Document Number** **288117-70205**	Rev/Version 1.0	Sht 22 of 49

Title: Neuro Patient Programmer Platform Electrical DVT Report

	Real Time Clock Accuracy (seconds)				

4.3.4 A/D Measurements Test

4.3.4.1 Objective

To verify the A/D measurement accuracy meets the requirements specified in the *Internal Resources* section of the PEM Electrical Specification.

4.3.4.2 Method and Equipment

4.3.4.3 Test Cases

There are   test cases using the test values below:

Parameter	Test Values	Units

4.3.4.4 Acceptance Criteria

A/D Voltage	Test Value	Max Error (%)

4.3.4.5 Test Setup

1.

2.

3.

4.

![Medtronic logo] **Medtronic**	*Neurological*	**Document Number** **288117-70205**	**Rev/Version** 1.0	**Sht** 23 of 49
Title: Neuro Patient Programmer Platform Electrical DVT Report				

5.

4.3.4.6 *Test Procedure*
1.

2.
3.

4.

4.3.4.7 *RESULTS* **PASS**
All devices met the acceptance criteria.

![Medtronic logo] **Medtronic**	*Neurological*	**Document Number** **288117-70205**	**Rev/Version** 1.0	**Sht** 24 of 49

Title: Neuro Patient Programmer Platform Electrical DVT Report

		A/D Measurement (% ERROR)														
		Ambient Temp					Low Temp					High Temp				
Input	Level	Min	Max	Mean	Std dev		Min	Max	Mean	Std dev		Min	Max	Mean	Std dev	

4.3.5 D/A Control Voltages Test

4.3.5.1   Objective

To verify the D/A accuracy meets the requirements specified in the *Internal Resources* section of the PEM Electrical Specification.

4.3.5.2   Method and Equipment

4.3.5.3   Test Cases

There are   test cases using all combinations of test values below:

Medtronic	*Neurological*	**Document Number** **288117-70205**	**Rev/Version** 1.0	**Sht** 25 of 49
Title: Neuro Patient Programmer Platform Electrical DVT Report				

Parameter	Test Value	Units

4.3.5.4 *Acceptance Criteria*

D/A Voltage	Measurement point	Max % Error

4.3.5.5 *Test Setup*
1.
2.
3.

4.

4.3.5.6 *Test Procedure*
1.
2.
3.

4.3.5.7 *RESULTS* **PASS**

All devices met the acceptance criteria.

	D/A Control Voltage (% ERROR)	

4.4 Transmit Telemetry (Downlink) Tests

4.4.1 Magnetic Field Intensity Test

4.4.1.1 *Objective*

To verify downlink magnetic field intensity meets the requirements specified in the *Transmit Telemetry (Downlink)* section of the PEM Electrical Specification.
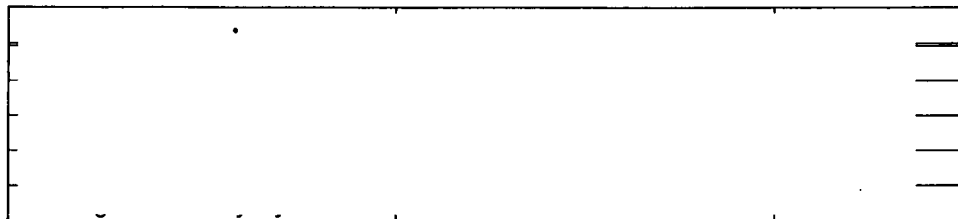
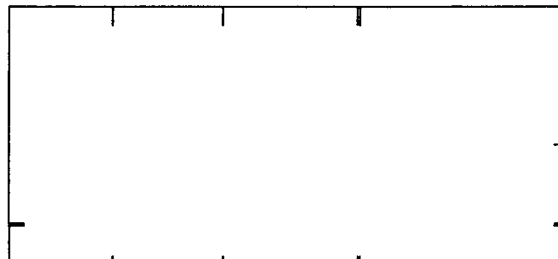| **Medtronic**	*Neurological*	**Document Number** **288117-70205**	Rev/Version 1.0	Sht 26 of 49
Title: Neuro Patient Programmer Platform Electrical DVT Report				

4.4.1.2   *Method and Equipment*

4.4.1.3   *Test Cases*

There are   test cases at   kHz using all combinations of test values below:

4.4.1.4   *Acceptance Criteria*

4.4.1.5   *Test Setup*

1.

2.

3.

4.

5.

4.4.1.6   *Test Procedure*

1.

2.

3.

4.

![Medtronic logo] **Medtronic**	*Neurological*	**Document Number** 288117-70205	Rev/Version 1.0	Sht 27 of 49

Title: Neuro Patient Programmer Platform Electrical DVT Report

5.

4.4.1.7 *RESULTS* **PASS**

All devices met the acceptance criteria.

Magnetic Field Intensity (A/m)

4.4.2 Burst Characteristics Test

4.4.2.1 *Objective*

To verify downlink burst characteristics of width, rise time, fall time, frequency, and overshoot meet the requirements specified in the *Transmit Telemetry (Downlink)* section of the PEM Electrical Specification.

4.4.2.2 *Method and Equipment*

4.4.2.3 *Test Cases*

There are   test cases using all combinations of test values below:

Parameter	Test Values	Units

![Medtronic]	*Neurological*	**Document Number** **288117-70205**	Rev/Version 1.0	Sht 28 of 49

Title: Neuro Patient Programmer Platform Electrical DVT Report

4.4.2.4   *Acceptance Criteria*

4.4.2.5   *Test Setup*
1.
2.
3.
4.

5.

4.4.2.6   *Test Procedure*
1.
2.

3.
4.
5.

4.4.2.7   *RESULTS*   **PASS**
All devices met the acceptance criteria.

![Medtronic logo] **Medtronic**	*Neurological*	**Document Number** **288117-70205**	Rev/Version 1.0	Sht 29 of 49

Title: Neuro Patient Programmer Platform Electrical DVT Report

Antenna	Voltage	Test	Burst Characteristics												
			Ambient Temp				Low Temp				High Temp			
			Min	Max	Mean	Std dev	Min	Max	Mean	Std dev	Min	Max	Mean	Std dev

![Medtronic logo] **Medtronic**	*Neurological*	**Document Number** 288117-70205	Rev/Version 1.0	Sht 30 of 49
Title: Neuro Patient Programmer Platform Electrical DVT Report				

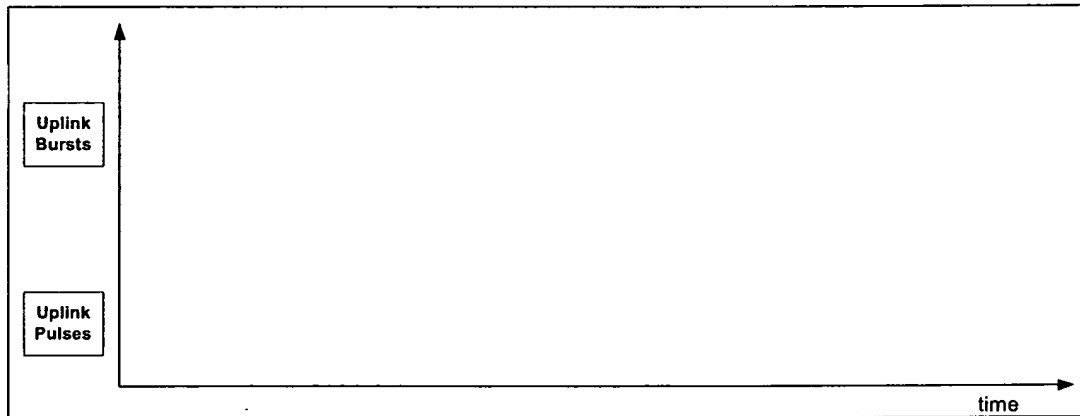## 4.5 Receive Telemetry (Uplink) Tests

4.5.1 Detection Threshold Test

4.5.1.1 *Objective*

To verify uplink detection threshold (i.e. receiver sensitivity) meets the requirements specified in the *Receive Telemetry (Uplink)* section of the PEM Electrical Specification.

4.5.1.2 *Method and Equipment*

Figure 1: Example Uplink Detection Threshold Test Waveforms

4.5.1.3 *Test Cases*

There are   test cases using all combinations of test values below:

Parameter	Test Values	Units

The supply voltage is 2.5 V.

![Medtronic] **Medtronic**	*Neurological*	**Document Number** **288117-70205**	Rev/Version 1.0	Sht 31 of 49
Title: **Neuro Patient Programmer Platform Electrical DVT Report**				

4.5.1.4 Acceptance Criteria

Antenna	Telemetry Type	Detection Onset (Uplink dB)	Detection Threshold (Uplink dB)	Maximum Input Level (Uplink dB)
		Max	Max	Max

4.5.1.5 Test Setup
1.
2.
3.
4.

5.

4.5.1.6 Test Procedure
1.
2.
3.

4.

4.5.1.7 RESULTS **PASS**
All devices met the acceptance criteria.

Antenna	Telemetry	Detection Threshold (dB)											
		Min	Max	Mean	Std dev	Min	Max	Mean	Std dev	Min	Max	Mean	Std dev

EXHIBIT B (cont.)

![Medtronic]	*Neurological*	Document Number 288117-70205	Rev/Version 1.0	Sht 32 of 49

Title: Neuro Patient Programmer Platform Electrical DVT Report

| Antenna	Telemetry	Maximum Input Level (pass/fail)		
		Pass	Pass	Pass
		Pass	Pass	Pass
		Pass	Pass	Pass
		Pass	Pass	Pass
		Pass	Pass	Pass
		Pass	Pass	Pass

4.5.2 Detection Margin Test

4.5.2.1 Objective

To verify uplink detection margin meets the requirements specified in the *Receive Telemetry (Uplink)* section of the PEM Electrical Specification.

4.5.2.2 Method and Equipment

Figure 2: Example Uplink Detection Margin Test Waveforms
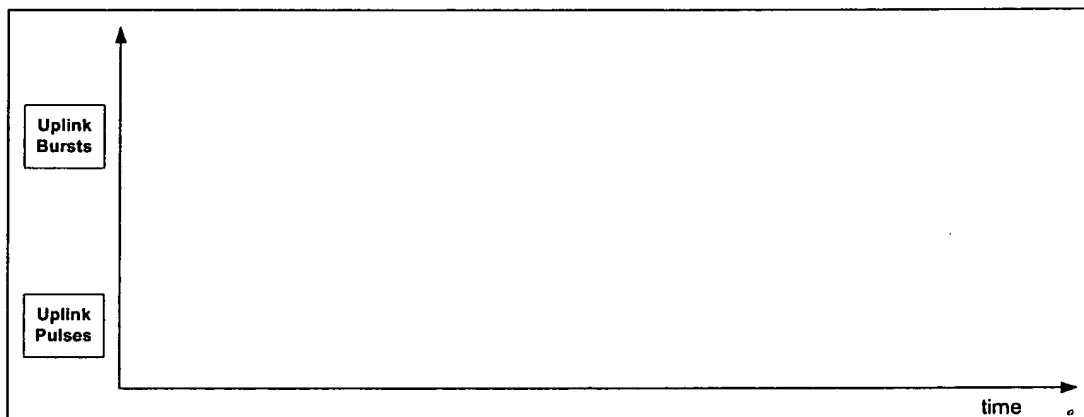
4.5.2.3 Test Cases

There are   test cases using all combinations of test values below:

![Medtronic logo] **Medtronic**	*Neurological*	**Document Number** **288117-70205**	**Rev/Version** 1.0	**Sht** 33 of 49

Title: Neuro Patient Programmer Platform Electrical DVT Report

Parameter	Test Values	Units
___	___	___
___	___	___
___	___	___
___	___	___

4.5.2.4 *Acceptance Criteria*

Telemetry Type	Data Bursts	Amplitude A1	Antenna	Detection Margin (Uplink dB)	
				Min	Max

4.5.2.5 *Test Setup*
1.
2.
3.
4.

5.

4.5.2.6 *Test Procedure*
1.
2.
3.

4.

4.5.2.7 *RESULTS* **PASS**
All devices met the acceptance criteria.

![Medtronic logo] **Medtronic**	*Neurological*	**Document Number** **288117-70205**	**Rev/Version** 1.0	**Sht** 34 of 49

Title: Neuro Patient Programmer Platform Electrical DVT Report

Antenna	Telemetry	Detection Margin (dB)													
										)					
		Min	Max	Mean	Std dev		Min	Max	Mean	Std dev		Min	Max	Mean	Std dev

4.5.3 Noise Immunity Test

4.5.3.1   Objective

To verify uplink noise immunity meets the requirements specified in the *Receive Telemetry (Uplink)* section of the PEM Electrical Specification.
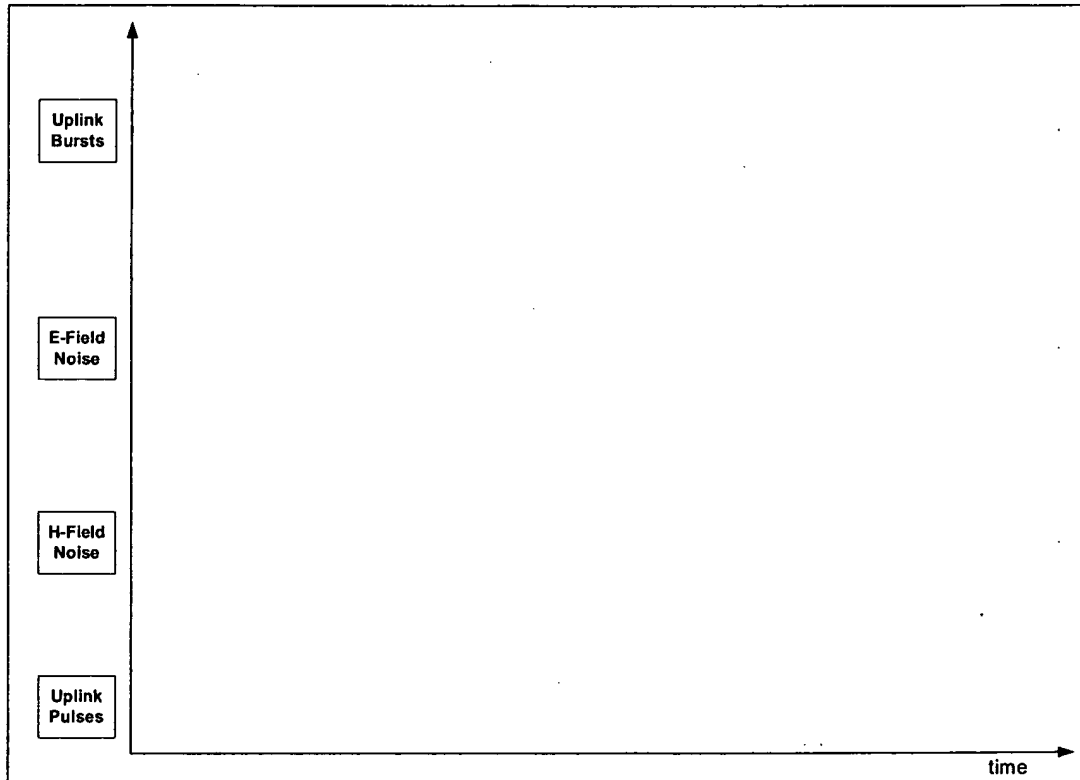
4.5.3.2   Method and Equipment

![Medtronic logo] **Medtronic**	*Neurological*	Document Number 288117-70205	Rev/Version 1.0	Sht 35 of 49

Title: Neuro Patient Programmer Platform Electrical DVT Report

Figure 3: Example Uplink Noise Immunity Test Waveforms

4.5.3.3   *Test Cases*

There are   test cases using all combinations of test values below:

Parameter	Test Values	Units

![Medtronic logo] **Medtronic**	*Neurological*	**Document Number** **288117-70205**	Rev/Version 1.0	Sht 36 of 49

Title: Neuro Patient Programmer Platform Electrical DVT Report

4.5.3.4 *Acceptance Criteria*

Telemetry Type	Uplink Level A1 (dB)	Antenna	Min E-Noise Immunity (dB)	Min H-Noise Immunity (dB)

4.5.3.5 *Test Setup*
1.
2.
3.
4.
5.

6.

4.5.3.6 *Test Procedure*
1.
2.
3.
4.

5.

4.5.3.7 *RESULTS* **PASS**
All devices met the acceptance criteria.

![Medtronic logo] **Medtronic**	*Neurological*	**Document Number** 288117-70205	**Rev/Version** 1.0	**Sht** 37 of 49

Title: Neuro Patient Programmer Platform Electrical DVT Report

Antenna	Noise	Telemetry	Noise Immunity (dB)													
			Min	Max	Mean	Std dev		Min	Max	Mean	Std dev		Min	Max	Mean	Std dev

4.5.4 Signal Distortion Test

4.5.4.1 Objective

To verify uplink signal distortion meets the requirements specified in the *Receive Telemetry (Uplink)* section of the PEM Electrical Specification.

4.5.4.2 Method and Equipment

![Medtronic] **Medtronic**	*Neurological*	Document Number 288117-70205	Rev/Version 1.0	Sht 38 of 49
Title: Neuro Patient Programmer Platform Electrical DVT Report				

4.5.4.3   *Test Cases*

Parameter	Test Values	Units

There are   test cases for Tel A, and   test cases for Tel N.

4.5.4.4   *Acceptance Criteria*

Telemetry Type	Uplink Level A1 (dB)	Antenna	Interval Distortion (µS)	Active/Idle Distortion (µS)

4.5.4.5   *Test Setup*
1.
2.
3.
4.

5.

4.5.4.6   *Test Procedure*
1.
2.
3.

4.

4.5.4.7   *RESULTS*   **PASS**
All devices met the acceptance criteria.

Medtronic	*Neurological*	**Document Number** 288117-70205	Rev/Version 1.0	Sht 39 of 49

Title: Neuro Patient Programmer Platform Electrical DVT Report

Antenna	Test	Uplink (dB)	Signal Distortion Telemetry A (us)											
			Min	Max	Mean	Std dev	Min	Max	Mean	Std dev	Min	Max	Mean	Std dev

Antenna	Test	Uplink (dB)	Signal Distortion Telemetry N, 0's (us)											
			Min	Max	Mean	Std dev	Min	Max	Mean	Std dev	Min	Max	Mean	Std dev

	Neurological	Document Number 288117-70205	Rev/Version 1.0	Sht 40 of 49

Medtronic

Title: Neuro Patient Programmer Platform Electrical DVT Report

Antenna	Test	Uplink (dB)	Signal Distortion Telemetry N, 1's (us)												
			Min	Max	Mean	Std dev		Min	Max	Mean	Std dev		Min	Max	Mean	Std dev

4.5.5 Turnaround Time Test

4.5.5.1 Objective

To verify uplink turnaround time meets the requirements specified in the *Receive Telemetry (Uplink)* section of the PEM Electrical Specification.

4.5.5.2 Method and Equipment

4.5.5.3 Test Cases

There are   test cases using all combinations of test values below:

Parameter	Test Values	Units

![Medtronic logo] **Medtronic**	*Neurological*	Document Number 288117-70205	Rev/Version 1.0	Sht 41 of 49
Title: Neuro Patient Programmer Platform Electrical DVT Report				

4.5.5.4 *Acceptance Criteria*

Supply Voltage	H-Bridge Drive Duty Cycle	Turnaround Time (mS)

4.5.5.5 *Test Setup*
1.
2.

3.

4.5.5.6 *Test Procedure*
1.

2.
3.
4.

4.5.5.7 *RESULTS* **PASS**

All devices met the acceptance criteria.

Test	Turnaround Time (pass/fail)

4.5.6 Hold Drift Test

4.5.6.1 *Objective*

To verify the hold drift meets the requirements specified in the *Receive Telemetry (Uplink)* section of the PEM Electrical Specification.

4.5.6.2 *Method and Equipment*

![Medtronic]	*Neurological*	Document Number 288117-70205	Rev/Version 1.0	Sht 42 of 49

Title: Neuro Patient Programmer Platform Electrical DVT Report

4.5.6.3 <u>*Test Cases*</u>

There is   test case:

Parameter	Uplink Level	Units

4.5.6.4 <u>*Acceptance Criteria*</u>

Time after hold circuit enabled	Max Hold Drift

4.5.6.5 <u>*Test Setup*</u>

1.
2.

3.

4.5.6.6 <u>*Test Procedure*</u>

1.
2.
3.
4.

5.

6.
7.
8.
9.
10

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Title: Neuro Patient Programmer Platform Electrical DVT Report				

4.5.6.7 *RESULTS* **PASS**

All devices met the acceptance criteria.

Hold Drift (mV)

4.5.7 New-Battery FET Test

4.5.7.1 *Objective*

To verify that enabling the new-battery FET circuit reduces the receiver noise floor (ambient RF energy detected by the receiver circuit) when new batteries are used.

4.5.7.2 *Method and Equipment*

4.5.7.3 *Test Cases*

There is   test case:

Parameter	Uplink Level	Units

4.5.7.4 *Acceptance Criteria*

Supply Voltage	New-Battery FET	RSSI Peak

4.5.7.5 *Test Setup*

1.

2.

3.

⊕ **Medtronic**	*Neurological*	**Document Number** 288117-70205	**Rev/Version** 1.0	**Sht** 44 of 49
Title: Neuro Patient Programmer Platform Electrical DVT Report				

4.5.7.6 Test Procedure

1.

2.

3.

4.

5.

6.

7.

4.5.7.7 RESULTS PASS

All devices met the acceptance criteria.

	New-Battery FET (mV)											
	Min	Max	Mean	Std dev	Min	Max	Mean	Std dev	Min	Max	Mean	Std dev

4.6 Telemetry Performance Tests

4.6.1 Telemetry Map Area at a Fixed Distance Test

4.6.1.1 Objective

To verify telemetry performance in terms of map area at a fixed distance meets the requirements specified in the *Telemetry Performance* section of the PEM Electrical Specification.

4.6.1.2 Method and Equipment

EXHIBIT B (cont.)

![Medtronic logo] **Medtronic**	*Neurological*	**Document Number** **288117-70205**	Rev/Version 1.0	Sht 45 of 49

Title: Neuro Patient Programmer Platform Electrical DVT Report

4.6.1.3 *Test Cases*

Parameter	Test Values	Units

There are   test cases.

4.6.1.4 *Acceptance Criteria*

IPG	Antenna	Map Area @ 5cm

4.6.1.5 *Test Setup*
1.
2.

4.6.1.6 *Test Procedure*

1.
2.
3.
4.
5.
6.
7.
8.

4.6.1.7 *RESULTS* **PASS**

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Title: Neuro Patient Programmer Platform Electrical DVT Report

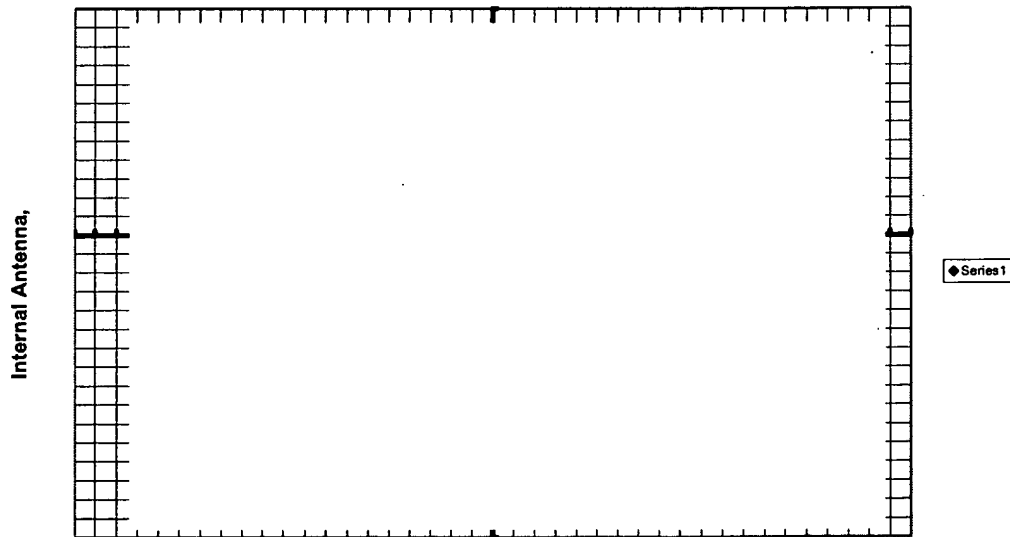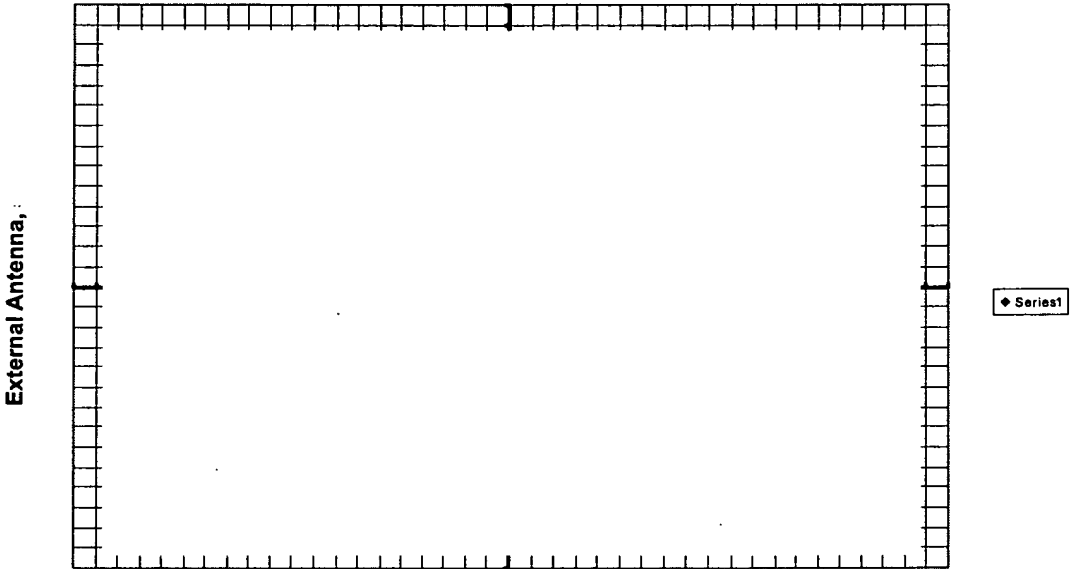4.6.1.7.1   Internal Antenna Map @
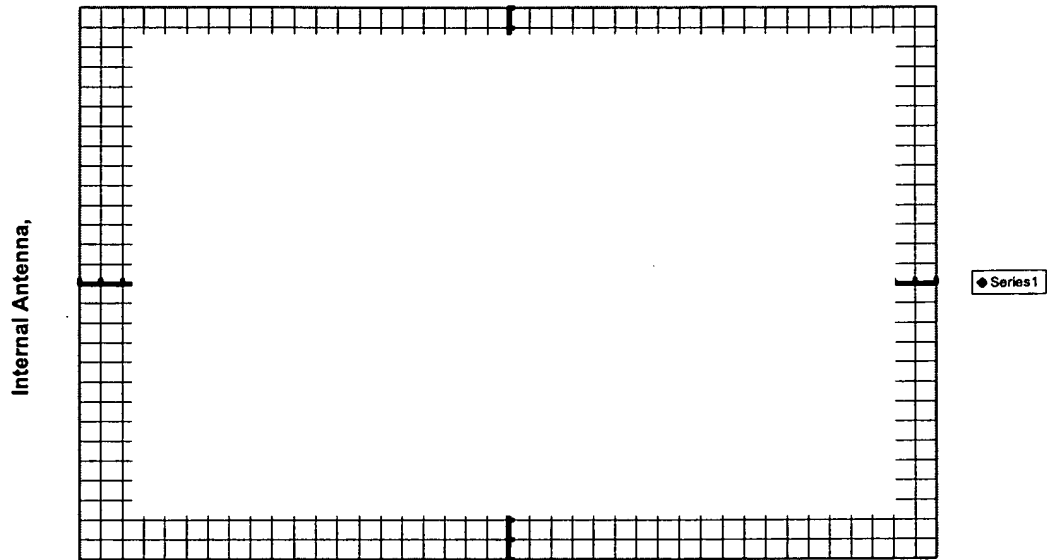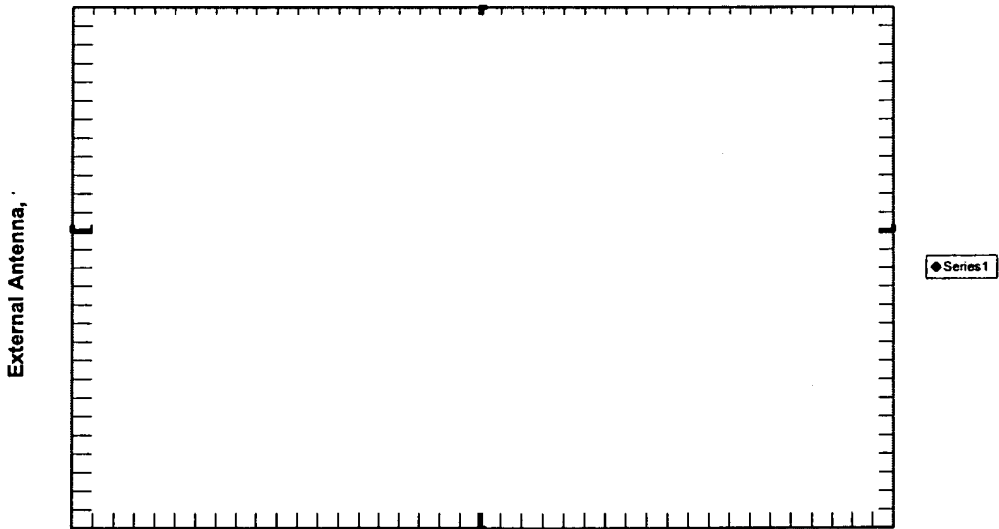

4.6.1.7.2   Internal Antenna @

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Title: Neuro Patient Programmer Platform Electrical DVT Report				

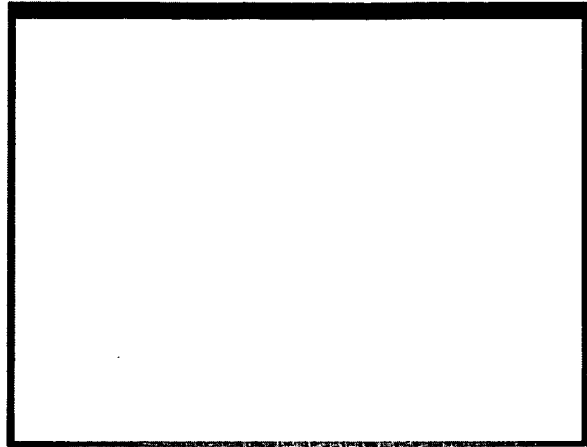4.6.1.7.3　　External Antenna Map @

4.6.1.7.4　　External Antenna @

4.6.1.7.5　　Photo of test fixture showing

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Title: Neuro Patient Programmer Platform Electrical DVT Report				

in this photo.

4.6.1.7.6   Photo of

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Title: Neuro Patient Programmer Platform Electrical DVT Report				

5   COMPLETION

This paragraph concludes this test specification.